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ETHNOBOTANICAL AND BIOLOGICAL ACTIVITIES OF *Leptadenia pyrotechnica* (Forssk.) Decne.: A REVIEW

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Abstract

Background: *Leptadenia pyrotechnica* is traditionally used for treating various diseases. This species holds variety of bioactive constituents that trigger healing properties. The present review was aimed to analyze nutritional, phytochemical and pharmacological activities of *L. pyrotechnica*.
Materials and Methods: The present review regarding *Leptadenia pyrotechnica* (Forssk.) Decne. Is the compilation of data from the previous research works conducted by various scientists across the world. Various published papers, medicinal plant databases, etc were utilized to compile the information.
Results: *L. pyrotechnica* is a wonderful desert plant belongs to the family Asclepiadaceae This plant possesses antifungal, antibacterial, anticancer, antioxidant, wound healing, anthelmintic, antiatheroscloretic, hypolipidemic, antdiabetic and hepatoprotective activities coupled with other multifarious uses. Almost all plant parts are used in the traditional medicinal system to treat various disorders.
Conclusion: This review includes the substance of different ethnobotanical uses, phytochemistry and exclusive capability of this plant in the field of anti-microbial and human disease activities.

Key words: *Leptadenia pyrotechnica*, Biological activities, Desert plant, Ethnobotanical, Phytochemical activity, phytochemistry.

Introduction

The history of medicinal pant is parallel to the human beings. People use the native plants to fulfill their basic needs. They are the cheap source for the extraction of structurally novel compounds (Shaw & Singh, 2014). Plants are source of inspiration to halt the emerging infections and diseases (Khan& Hanatu, 2013). Medicinal plants are indigenously used for different purposes throughout the globe. They performed cardiac role in the traditional medicinal systems. Instead of plant's importance in medicines or traditional medicinal systems, only 5% are analyzed for their potential and 95% are still remains (Mukherjee, 2004).

Phytogeographical Distribution

Leptadania pyrotechnica (Forssk.) Decne. is a typical desert plant belongs to the Asclepiadaceae family (Ali et al., 2001). It is leafless, erect and evergreen shrub commonly known as Khimp, Kheep or Khip (Qureshi et al., 2012), which is used for multipurpose (Sadeq et al., 2014). It is native to Mediterranean regions, semi-arid deserts of African and Asian countries, where sandy and dry conditions prevail. It is also growing in northern dry sandy Sahel and in the western India (Burkill, 1985; McLaughlin, 2006). In Pakistan, it is present in the sandy deserts of Punjab, Sindh and Baluchistan. It is frequently found on sand dunes and interdunal flats in the Cholistan desert and used as medicinal plant (Hameed et al., 2011). It is also found along the seacoast (Ali et al., 2001). Locally it is known as Khip or Barda in Pakistan (Qureshi, 2004; Qureshi, 2013). It is planted in the month of September (Moustafa et al., 2007). Recently, it is also cultivated in forests, farms and on the roadsides (Khasawneh et al., 2011).

Morphology

Leptadenia pyrotechnica (Fig. 2) is a perennial, ascendingly growing, profusely branched shrub that is 0.5 to 3 meter in height. The stem is glabrous, green to pale yellow in color and have watery fluid/sap. It is leafless to deciduous small leaves which usually fall in the early stage of development. The flowers are yellowish green, bisexual, pentamarous and actinomorphic. The sepals are joined at the base and free at above and sympetalous. Blooming and fruiting time is August to January (Verma et al., 2014). It has pod like fruits that are cooked as vegetable. Its seeds are hairy in the form of tufts. Its roots are good soil binder that fixes the sand dunes due to elongated and extensive root system (Qureshi et al., 2012).

Ethnobotanical Uses

In an ethnobotanical study of Cholistan desert in Pakistan by Ahmed et al. (2012) revealed the use of *L.pyrotechnica* for constipation, obesity and dysmenorrhea. For this purpose the powdered leaf and shoot were used. Qasim et al., (2014) reported that the decoction of this plant is popularly used as a traditional ethno-medicine for upper gastrointestinal track (UGT) disorder,

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Spermatorrhiea & impotency near the coastal areas of Pakistan. In Saudi Arabia, the decoction of seeds and whole plant is used to treat flu, lectogauge and tussive (Randa & Youssef, 2013). Watery juice of this plant is used against ringworm. Young branches are used to make ropes along with *Crotalaria burhia* in Nara desert (Bhatti et al., 2001). constipation, obesity and dysmenorrhea flu, lectogauge and tussive muscle and kidney pain cold ringworm skin diseases and diabetes diuretic tuberculosis fever, hepatitis, constipation and obesity For the cough and cold, the stem juice was used two times in a day through nostrils in Mali (Diallo et al., 1999). While in Senegal, it is used for infant children as laxative and also used for muscle and kidney pain. For the removal of thorn or thorn injury, its leaf paste or latex is applied. The latex is also applied to remove ringworm (Qureshi, 2002). Its fiber has expectorant activity (Al-Yahiya, 1986). To remedy the skin diseases and diabetes, plant sap was applied (Parveen et al., 2007). Its stem is diuretic and used for the removal of kidney stones. *L. Pyrotechnica* extract is remarkably lower the rate of plaque formation in aorta (Saleh et al., 2012). Its roots are used as vegetables (Ali et al., 2001). It was reported that its boiled filtrate is used two times in a day orally to cure tuberculosis (TB) (Petal et al., 2014). People use their pods as vegetable. Its branches are soaked overnight in water and then used in making ropes used in huts formation (Qureshi, 2002). Some of the significant traditional uses summarized in Table 1.

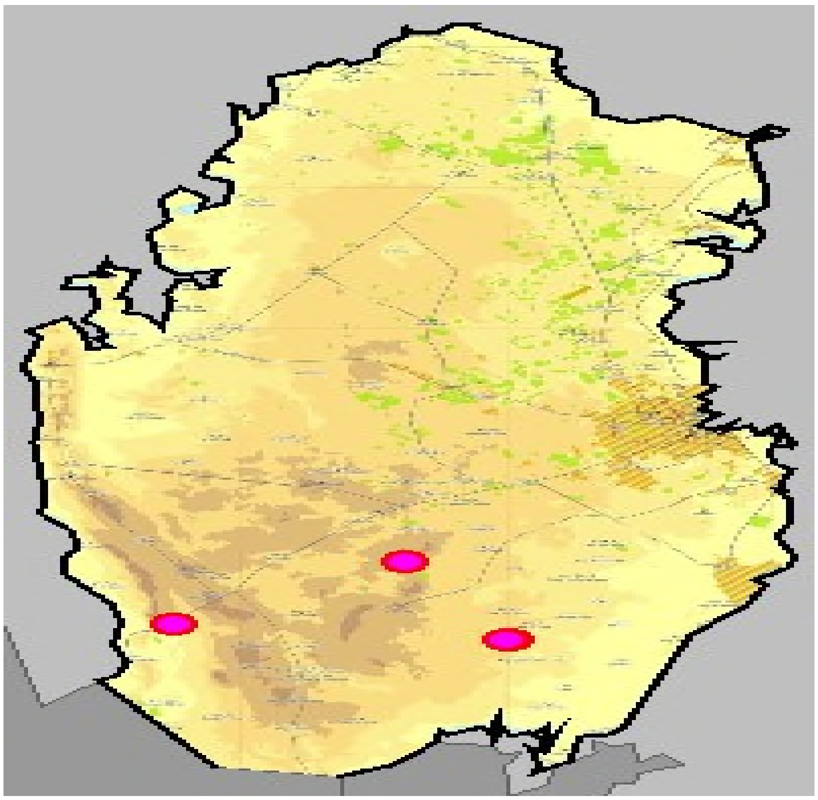

Figure 1: Worldwide distribution of *L. pyrotechnica.*

(a) **(b)**

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(c) (d)

Figure 2: a. plant, b. seeds, c. flowers d. pods of *L. pyrotechnica*.

Table 1: Traditional uses of different Plant parts of *L. pyrotechnica*.

Sr. No.	Plant part	Uses	References
1.	Leaf paste	To remove the thorn/ thorn injury	Upadhyay et al., 2010
2.	Stem juice	To cure cough, flu	Diallo et al., 1999
3.	Plant fiber	Used as expectorant and antihistaminic	Al-Yahiya., 1986
4.	Plant sap	For skin diseases and diabetes, smallpox, psorosis	Kateva et al., 2006; Maydell, 1990
5.	Leaves and shoots	Used for fever, hepatitis, constipation and obesity	Ahmad et al., 2014
6.	Whole plant	It's warmed juice taken orally to remedy the jaundice	Sharma et al., 2012
7.	Seed	Macerated seed lotion is used as eye lotion	Burkill, 2004 & Maydell, 1990
8.	Yong twigs	Used as toothbrush	Maydell, 1990

Primary metabolites

Rekha et al., (2013) determined the primary metabolites in different plant parts of *L. pyrotechnica.* The primary metabolites are given in Table 2.

Table 2: Metabolites present in different plant parts of *L. pyrotechnica*.

Sr. No.	Plant parts	Composition
1.	**Root**	Protein (22.8±1.31mg/gdw), soluble sugars (24.2±1.42), lipid (22.9±1.38mg/gdw)
2.	**Stem**	Starch (38.5±1.34mg/gdw), Phenolic content (56.2±1.85mg/gdw)
3.	**Leaf**	Lipid (32.1±0.41gm/gdw), Starch (30.2±0.34gm/gdw)
4.	**Root**	Soluble sugars (80.2±0.46mg/gdw), Phenolic Contents (15.43±1.25mg/gdw)

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Pharmacology

Antifungal Activity

Rekha et al., (2013) evaluated antifungal activity of the leaves of *L. Pyrotechnica* to counter the four fungi viz., *Aspergillus niger, A. flavus, Fusarium oxysporium and F. moniliformis*. Among different extracts, methanol extract showed pronounced results against *A. flavus*, while, the aqueous extract responded more effective for *F. moniliformis*. While hexane and ethyl acetate have more resistant against *A. niger*. This activity might be due to the presence of alkaloids in the plant. By using this plant, certain antifungal reagents can be prepared by further working. The same antifungal and antibacterial activities also have been researched out very well in the literature (Fabry et al., 1998; Ahmad et al., 2000; Boer et al., 2005; Nair et al., 2005).

Antibacterial Activity

Al Fatimi et al. (2007) conducted an experiment to evaluate the antimicrobial activity by preparing methanolic, aqueous and Dichloromethane extract of whole plant of *L. pyrotechnica*. They checked the antimicrobial activity *in vitro* against *Staphylococcus aureus, Bacillus subtilis*, *Escherichia coli, Pseudomonas aeruginosa* and *Micrococcus flavus* by using agar diffusion and DPPH methods. At 10%, 50% concentrations showed the good results in human amniotic epithelial cell lines, while the same was weak against FL- cells. Another study carried out by Munazir et al., (2012) for the antibacterial activity of *L. pyrotechnica*. The root and fruit extract in eight different solvents i.e. water, n-hexane, methanol, chloroform, ethanol, acetone, butane and ethyleacetate were tested against *Staphylococcus epidermidis* and *S.aureus*. Root extract showed better results as compared to the fruit extract. While, methanolic extracts of both parts gave good results in inhibiting growth of both the pathogens.

Anticancer Activity

Khasawneh et al., (2011) experimented the plant extract in ethyl acetate of about (IC50 = 43.16 µg/mL). The extract showed anticancer activity against MCF-7 human breast cancer cell line. In the same experiment the antioxidant activity was evaluated. For this purpose water, ethyl acetate and n- butanol extracts of aerial parts of *L.pyrotechnica* were used that established significant activity.

Antioxidant Activity

To check the antioxidant activity, 2, 2'-azino-bis (3- ethylbenzothiazoline-6-sulfonic acid (ABTS), Ferric Reducing Antioxidant Power (FRAP) and β-carotene and 2, 2-diphenyl-1 –picrylhidrazyl (DPPH) assays were used. The good results are showed by FRAP followed by ABTS and DPPH assays (Saleh et al., 2012). Anti- inflammatory and antioxidant potential of *L. pyrotechnica* was also evaluated by using ethanolic extract of *L. pyrotechnica* EELP in 400mg/kg concentration on rats. The free radical activity of root and aerials parts of the plant was carried out by Munazir et al., (2015b) by using methanolic extract. The results showed that both plant parts possessed significant radical scavenging activity as compared to the synthetic drug i.e. Butylated Hydroxy Anisole (BHA). Aerial parts showed maximum electron donating activity at 100µg/ml, while root showed more radical scavenging activity.

Wound healing property

Wound healing activity of *L. pyrotechnica* was evaluated by Shaw & Singh (2014). They prepared ethanolic extract by taking root and aerial parts powder further into petroleum ether and ethanol. It was observed that 4% (w/w) aerial parts showed more wound healing activity than root extract in Wistar albino rats. This activity may be attributed to the presence of terpenoides and flavonoids that triggered astringent and antimicrobial property.

Anthelmintic activity

The anthelmintic activity of methanolic extract of *L. pyrotechnica* has profound effect on the GIT worms. Methanolic extract of 100 mg/ml showed the highest activity compared with the standard drug Albendazole (Kumar et al., 2011).

Antiatheroscloretic and hypolipidemic activity

A study was conducted by Jain et al., (2007) in which antiatheroscloretic and hypolipedemic activity of aerial parts of *L. pyrotechnica* was confirmed. Methanolic crude drug of Khimp was prepared and administered at 250 mg / wt. / day kg dose to the coconut fed albino rabbits. It was observed that methanolic extract considerably lowered the hepatic and aorta total cholesterol, LDL-cholesterol and HDL-cholesterol ratio, VLDL- cholesterol and triglycerides. On the other hand, it also prevented the plaque formation in the arteries. The mechanism behind this was the more cholesterol absorption in the intestine and increased the removal of cholesterol through fecal. In a review by Joshi & Jain (2014) on hypolipedemic and antioxidant activity of medicinal plants also revealed the hypolipedemic activity of *L. pyrotechnica*.

Antidiabetic activity

Chaudhary et al., (2011) conducted an experiment in which antdiabetic activity of *L. pyrotechnica* was evaluated in Straptozotocin induced diabetic rats. They administered the methanolic extract of *L. pyrotechnica* (MELP) to rats at 100, 200 & 300 mg/kg for 21 days. According to them, MELP administered rats exhibited the dosage dependent reduction in blood glucose along with reduction of glycogen in liver, cholesterol and triglycerides in serum.

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Hepatoprotective Activity

An experiment was conducted by Tewari et al., (2014) on the paracetamol treated rats by using albino wistar rats. Three groups viz., 1) control, 2) treated with paracetamol and 3) paracetamol treated and administered with the methanolic extraction of *L. pyrotechnica* was employed in the experiment. The paracetamol affected rats showed the symptoms of liver necrosis, reduced hepatocytes, cytoplasm vaculation and compression of sinusoids. The 3rd group treated with methanolic extraction showed 100% results with healthy liver compared to the controlled group. The *L. pyrotechnica* extract remarkably reduced the hepatic enzymes activities like SGOT, ALP & SGPT. The results showed that *L.pyrotechnica* has obvious hepatoprotective activity.

Anti-tumor activity

Moustafa et al., (2009a) conducted a study and evaluated the antitumor activity on the Brine shrimps. Alkaloids from aerial parts and alcoholic extracts were used in 63.09 and 11.89ppm concentration. Results showed that alkaloids and alcohol showed -33.6% and -49.3% antitumor activity, respectively. This activity was due to the presence of the alkaloids in the aerial parts.

Toxicity

Watafua and Geidam, (2014) examined the subacute toxicity of the ethanolic extract of *L. pyrotechnica* (EELP) tested on the albino rats for 21 days. Three concentrations viz., 50mg/kg, 100mg/kg and 150mg/kg of their weight were given to the three groups of Wister rats. After 21 days, the serum and liver of rats was taken to check the toxicity of EELP. The results showed that the administration of EELP was slightly toxic to the liver.

Phytochemistry

Qualitative phytochemical screening

Qualitative and quantitative phytochemical screening from root and aerial parts of *L. pyrotechnica* was determined by Munazir et al., (2015a). Eight polar and non-polar solvents (hexane, acetone, butanol, ethanol, methanol, ethyl acetate, water and chloroform) were used. The results revealed that both plant parts contained four major phytochemicals such as alkaloids, tannins, flavonoids and saponins. Besides, Methanolic extract extracted maximum phytochemicals than the rest of solvents.

Pyrotechnoic acid

Ali et al., (2001) in an experiment isolated the of triterpenoid compound belonging to the Olean series by using heteronuclear multiple bond correlation HMBC and hetero-COSY technique which. It was the new addition in the pentacyclic triterpenoid that was named as 3-glycol-oleanolic acid or Pyrotechnoic acid. Another pentacyclic triterpenoid was isolated from *L. pyrotechnica* by Noor et al., (1992). They named that chemical as leptadenol that was isolated by chemical and spectrometry analysis.

Fatty acid, hydrocarbons and terpenes

Chemical constituents such as sterols (stigmasterol, cholesterol, β-sitosterol, campasterol and fucosterol), terpenes (phytol, taraxerol and squalene), fifteen types of fatty acids that also include 11 n-alkanol, one n-alkene (3-tetradecne) and series of n-alkanes were investigated from aerial parts of *L. pyrotechnica* by Moustafa et al., (2007). . They identified these phytochemicals including 18 aromatic hydrocarbons 5-phenyl-undecane and 6-phenyl-tridecane as major element. Sherwani et al., (2009) reported 32% vernolic acid and different fatty acids isolated from the seeds of *L. pyrotechnica*.

Alkaloids

Moustafa et al., (2009b) performed an experiment and isolated six simple amines and 24 alkaloids by using aerial parts of *L. pyrotechnica*. These alkaloids were belonged to the indole, pyrrol, and pyrazine and pyridine groups.

Flavonoids

In another study conducted by Moustafa et al., (2009a) isolated six flavonoids from the Khip plant by using low pressure chromatography, high performance liquid chromatography and paper chromatography. These flavonoids included kaempferol-3-*O*-α-L-rhamnopyranosyl (1‴→6″)-*O*-β-D-glucopyranoside (E-I.1), kaempferol-3-*O*-β-D-rhamnopyranosyl (1‴→6″)-*O*-β-D-glucopyranoside (E-I.2), texasin-7-*O*-β-D-glucopyranoside E-II.2, kaempferol-3-*O*-β-D-glucopyranoside (E-III.1), kaempferol (E-IV.1) and kaempferide-3-*O*-α-L-rhamnopyranosyl (1‴→6″)-*O*-β-D-glucopyranoside (E-I.1a). The toxicity of these flavonoids was also checked on brine shrimps that showed that E-I, E-I.1 and E-I.2 cause more mortality than the rest of the flavonoids.

Cardiac glycosides

Three cardiac glycosides were isolated by Moustafa et al., (2009c) from the plant. These glycosides included 14, 19-dihydroxycard-20 (22)-enolide-3-*O*-[*β*-d-glucopyranosyl-*β*-d-digitoxoside] C-I, 14, 19-dihydroxycard-20 (22)-enolide-3-*O*-[*β*-d-glucopyranosyl-*β*-d-glucopyranoside] C-II and 14, 19-dihydroxycard-20 (22)-enolide-3-*O*-*β*-digitoxoside, C-III.

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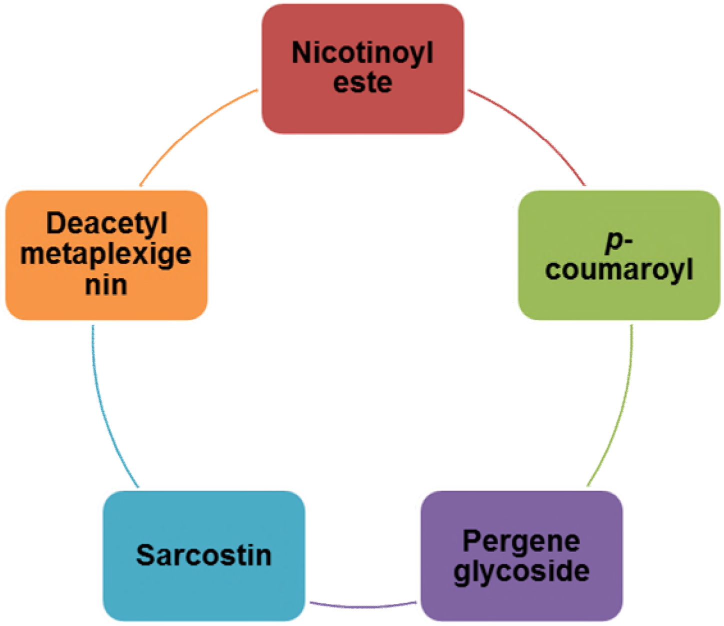
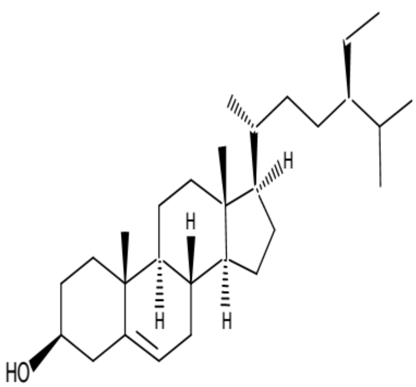
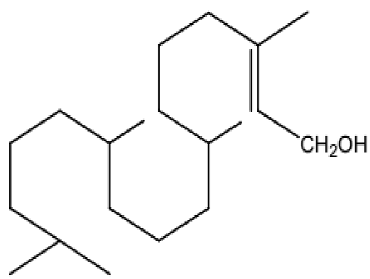


Figure 2: Key Phytochemicals screened from *L. pyrotechnica* (Ciofit al., 2006)

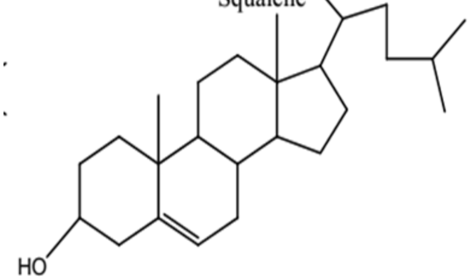


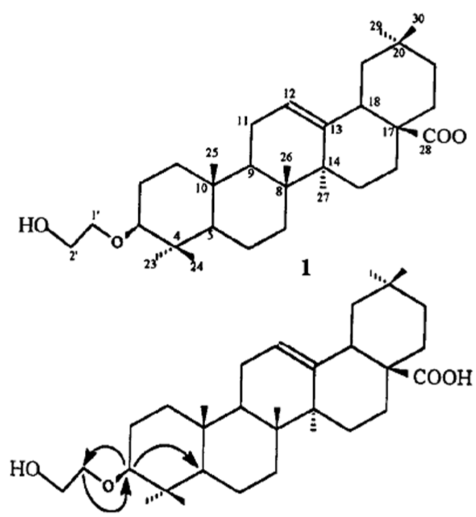
β-Sitosterol



Phytol

Squalene





Pyrotechnoic acid

Figure 3: Phytochemicals present in the *L. pyrotechnica.*

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Miscellaneous Uses

Biomass production

The role of *L. pyrotechnica* in biomass and productivity was studied by Singh et al., (2012) in desert. They divided the desert in three agro-climatic zones and concluded that the stem has more nitrogen and carbon contents than the roots. The carbon and nitrogen contents in the stem were 43.32%, - 45.86 and 0.41% - 2.21%, respectively; while the root contained 39.45%, - 42.51% N and 0.57%, - 1.69% C. These results indicated the soil binding and stabilizing potency of Khip plant in desert.

Water purification

Shyam & Kalwania, (2013) stated that *L. pyrotechnica* possessed the high amount of calcium ions that have the ability to interact with negatively charged fluorides. In India, this property was used to precipitate out the high concentration of fluorides ion by using Khimp powder in Sikar aquifers.

Khip fiber

Stem of Khip plant is the source of bast fiber. It is lignocellulosic in composition and has short fibers. Mojumder et al., (2001) studied the chemical characteristics of khip fiber. They obtained the fiber by crushing the green stem and then retting it. According to them, 8-10% khip fiber can be obtained from the green stem. Based on its physical and chemical properties, khip fiber can be used in pulp, cellulosic and paper industry as raw material. Due to its short fibers, it can be used only with other fibers like cotton to produce polyester and other goods. The khip plant also used to make handmade paper and for making boards (Kundu et al., 2005).

Biotechnological work:

Dutta et al., (2012) carried out experiment on the gene insertion in *L. pyrotechnica* due to its multipurpose use. For this purpose, gus and gfp proteins were transferred by agrobacterium mediated transformation. The expression of transferred proteins was evaluated at different plant stages. For this purpose, five day old hypocotyl of seedling was chosen. The transgenic plants were evaluated by polymerase chain reaction (PCR) and southern blotting. The results showed the successful gene transformation that could be used for the insertion of desired genes in *L. pyrotechnica* in future.

Plant conservation and management

Due to the highly medicinal value and rapid usage of the *L. pyrotechnica*, it was necessary to conserve the plant for future. Various studies have been carried out on the ecological, ethnobotanical and biochemical aspects of that plant. In literature, micropropagation of *L. pyrotechnica* has been reported (Parabia et al., 2007; Sudipta et al., 2011). The callus formation was performed by using plant hormones (i.e. Cytokinin & Auxin) from the explant parts (Qureshi et al., 2012). Results revealed that the nodal parts were more efficient for callus induction (90%) than the internodal (5%) and pod (no callus formation) explants. This was the first time to produce efficient callus from the nodal parts of plant (Qureshi et al., 2012). *In vitro* shoot multiplication was performed by (Dagla et al., 2012) by using cotyledonary nodes of explant of *L. pyrotechnica*. The shoots were firstly planted in nursery and then in the natural habitat successfully. The experiment on the somatic embryogenesis was devised by Sadeq et al., (2014) to conserve that endangered plant in Bahrain. In this experiment various amounts of IAA and BAP were used. 8.88µM IAA and 1.14µM BAP showed the maximum callus induced plant regeneration.

Conclusion

Desert landscapes are the world’s contour images of vast barren lands with scanty thorny plants having enormous medicinal values. These plants possess numerous phytochemicals that play an important role as active constituents. *L. pyrotechnica* is one of those desert plants that have multiple uses. This species possesses antifungal, antibacterial, anticancer, antioxidant, wound healing, anthelmintic, antiatheroscloretic, hypolipidemic, antdiabetic and hepatoprotective activities coupled with other multifarious uses. Present review is just a glimpse to attract the scientists to divert their attention towards deserts and particularly to further develop the existing remedial potential of *L. pyrotechnica* for the development of modern medicine in future.

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